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(54) **TOUCHING AN ANTENNA OF A NEAR FIELD COMMUNICATIONS (NFC) DEVICE TO CONTROL ITS OPERATION**

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H01Q 1/22 (2006.01)
H01Q 11/12 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/22*** (2013.01)

(58) **Field of Classification Search**
USPC 455/41.1
See application file for complete search history.

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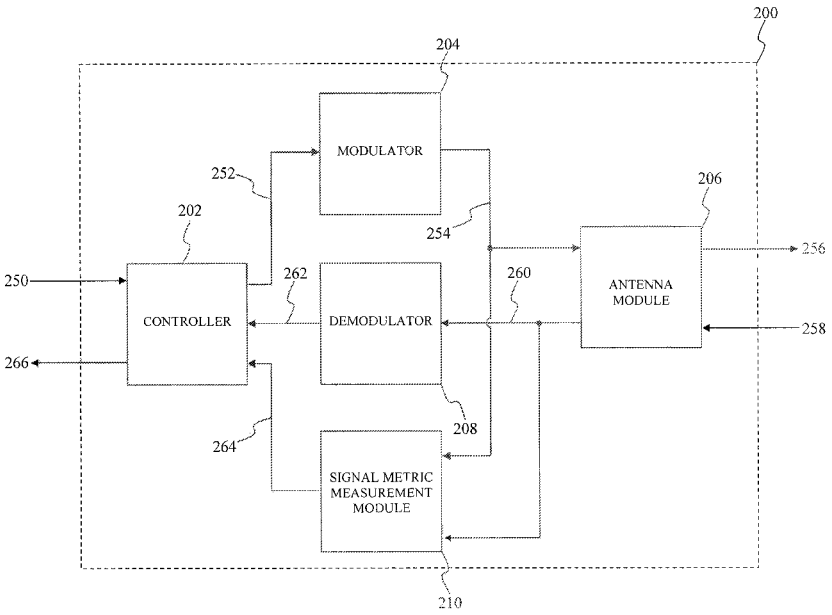
(74) *Attorney, Agent, or Firm* — Sterne, Kessler, Goldstein & Forr, P.L.L.C.

(57) **ABSTRACT**

A near field communications (NFC) device is disclosed that interacts with other NFC devices to exchange information and/or the data. An operator may touch, or be sufficiently proximate to, an antenna module of the NFC device to operate and/or control the NFC device. The antenna module includes antenna components that are characterized by a corresponding characteristic impedance. The touch, or sufficient proximity, of the operator changes the corresponding characteristic impedance of antenna components. The NFC device may determine a location of the touch, or proximity, of the operator based upon this change. The NFC device may interpret the location of the touch, or proximity, of the operator as information from the operator to operate and/or control the NFC device.

20 Claims, 12 Drawing Sheets



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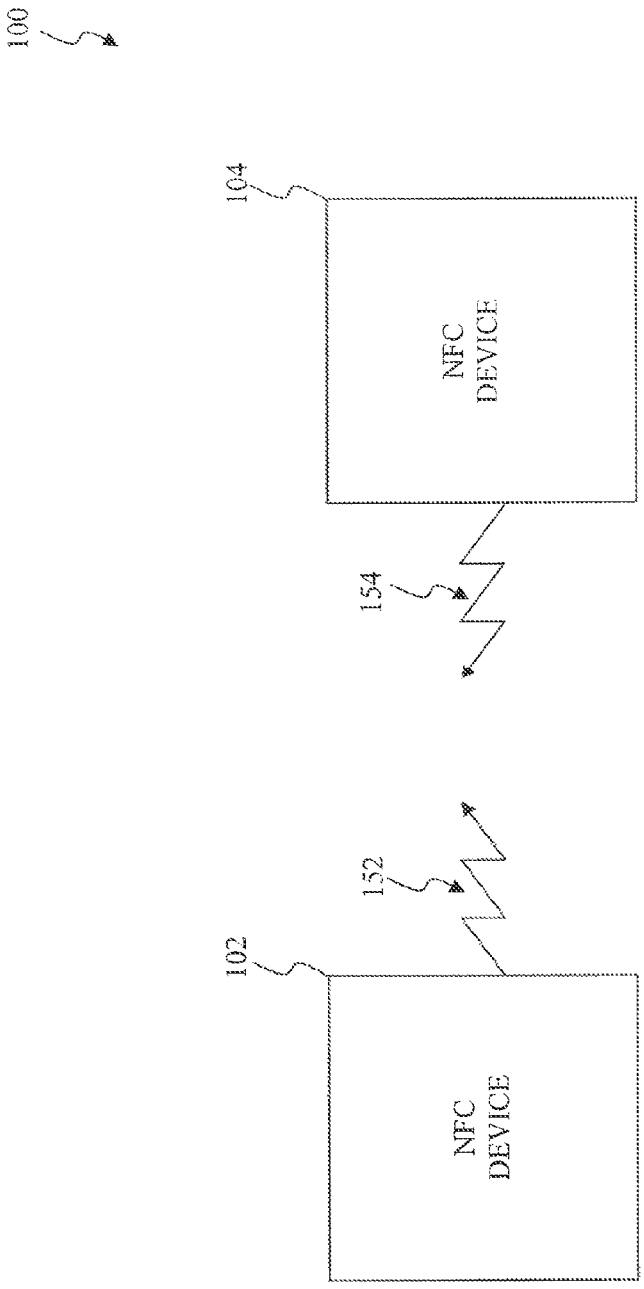
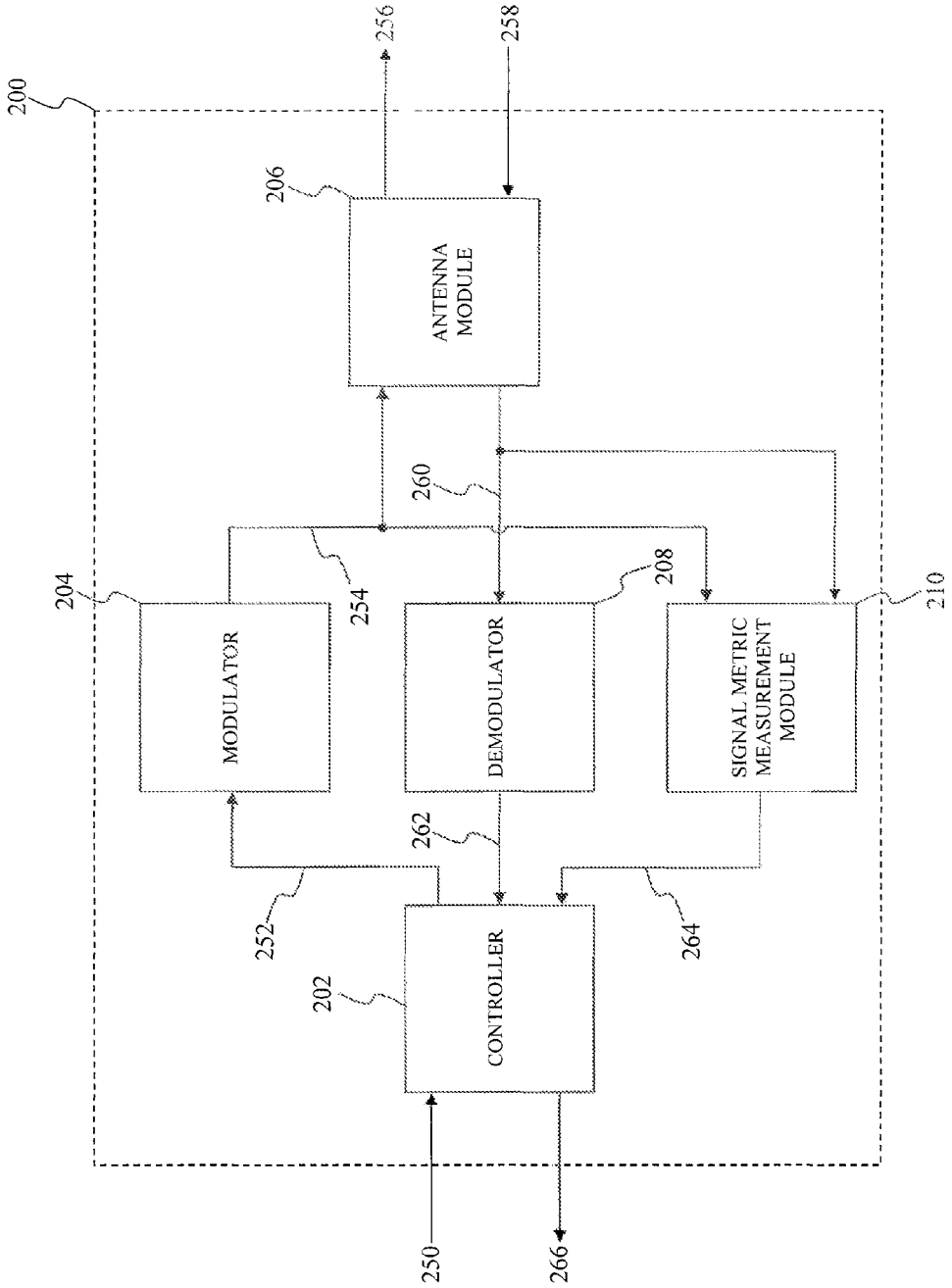


FIG. 1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260
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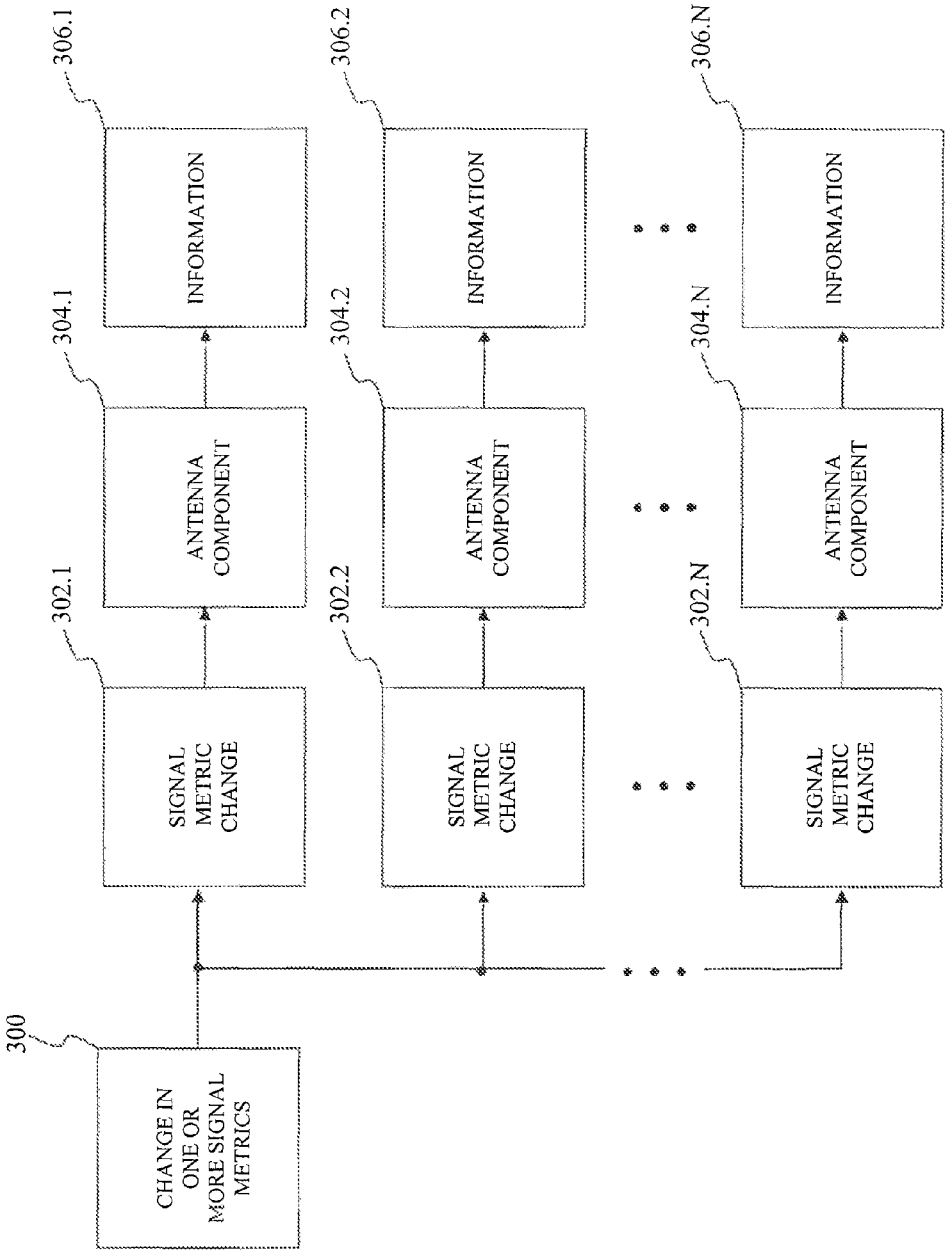
252
264
202
CONTROLLER
250
266

FIG. 2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302.2
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304.2
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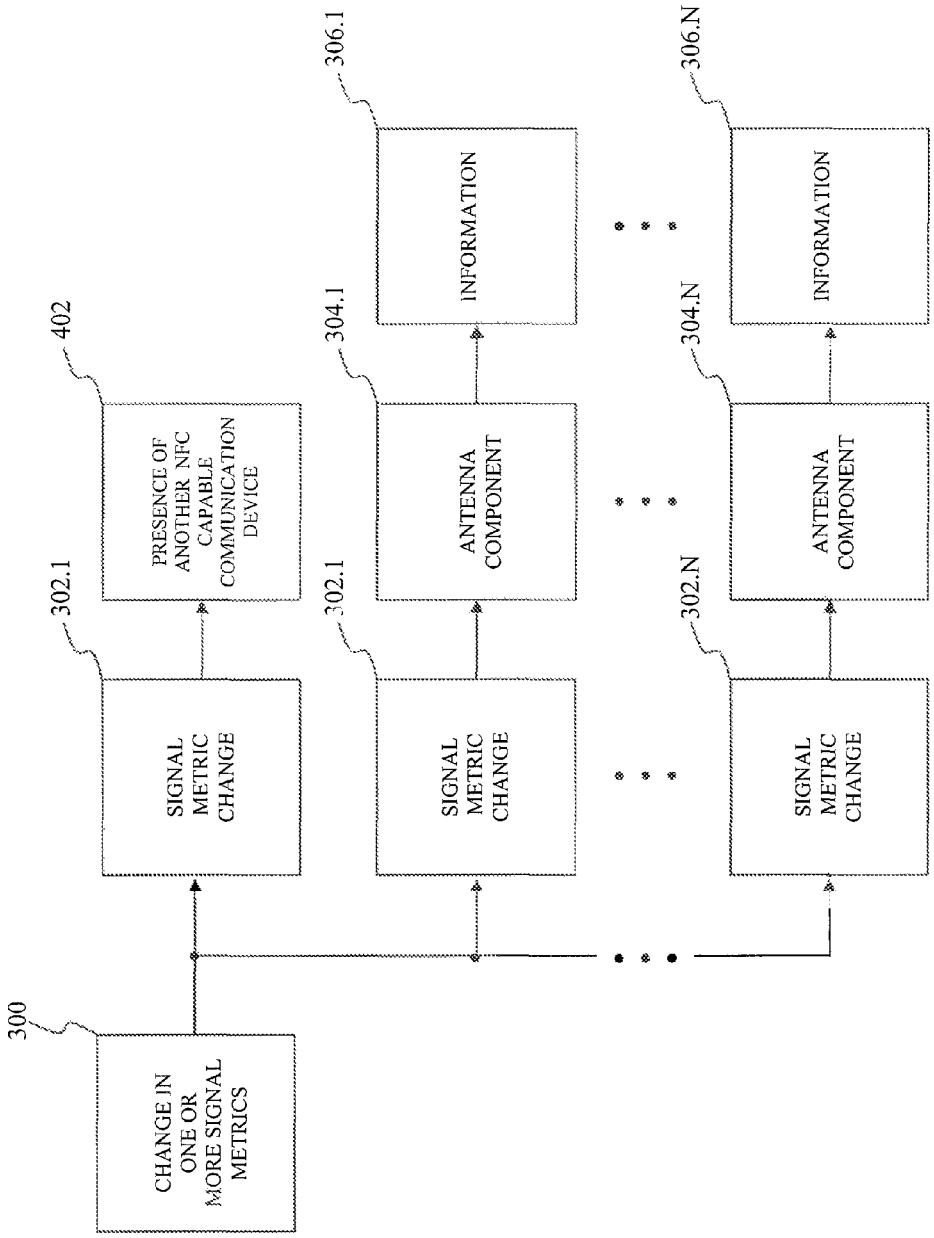
INFORMATION
306.2
INFORMATION
306.N
INFORMATION

FIG. 3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INFORMATION
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PRESENCE OF ANOTHER NFC CAPABLE COMMUNICATION DEVICE

FIG. 4

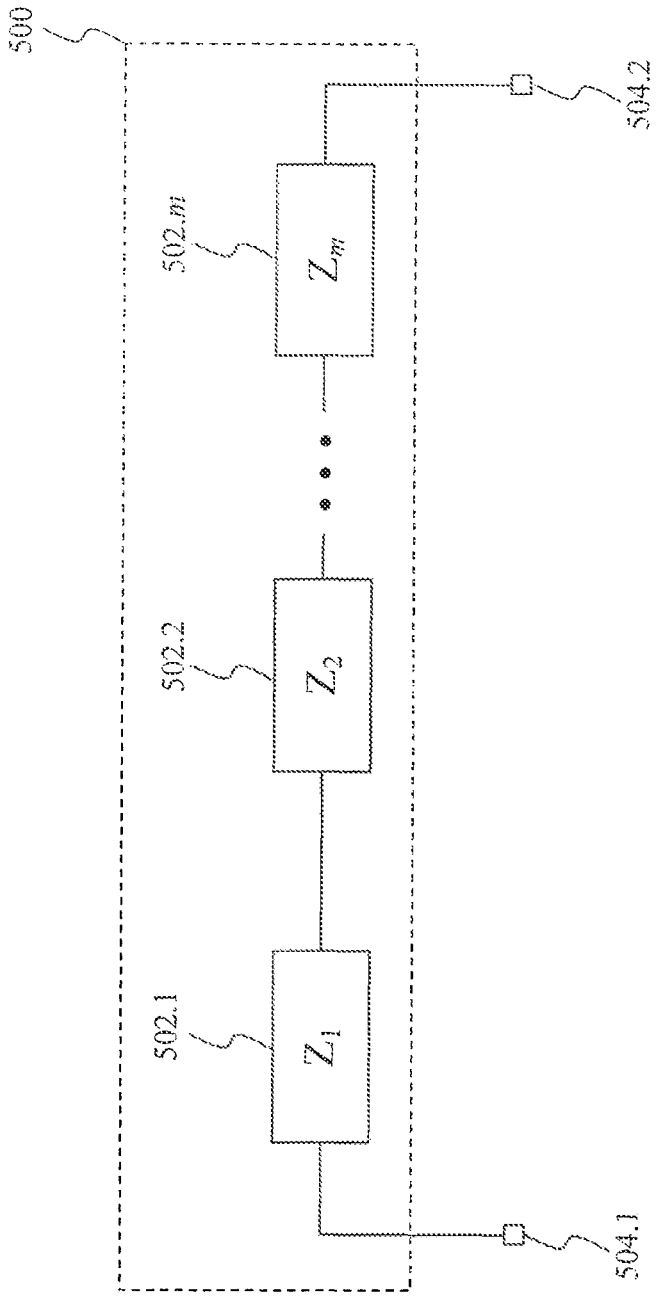


FIG. 5

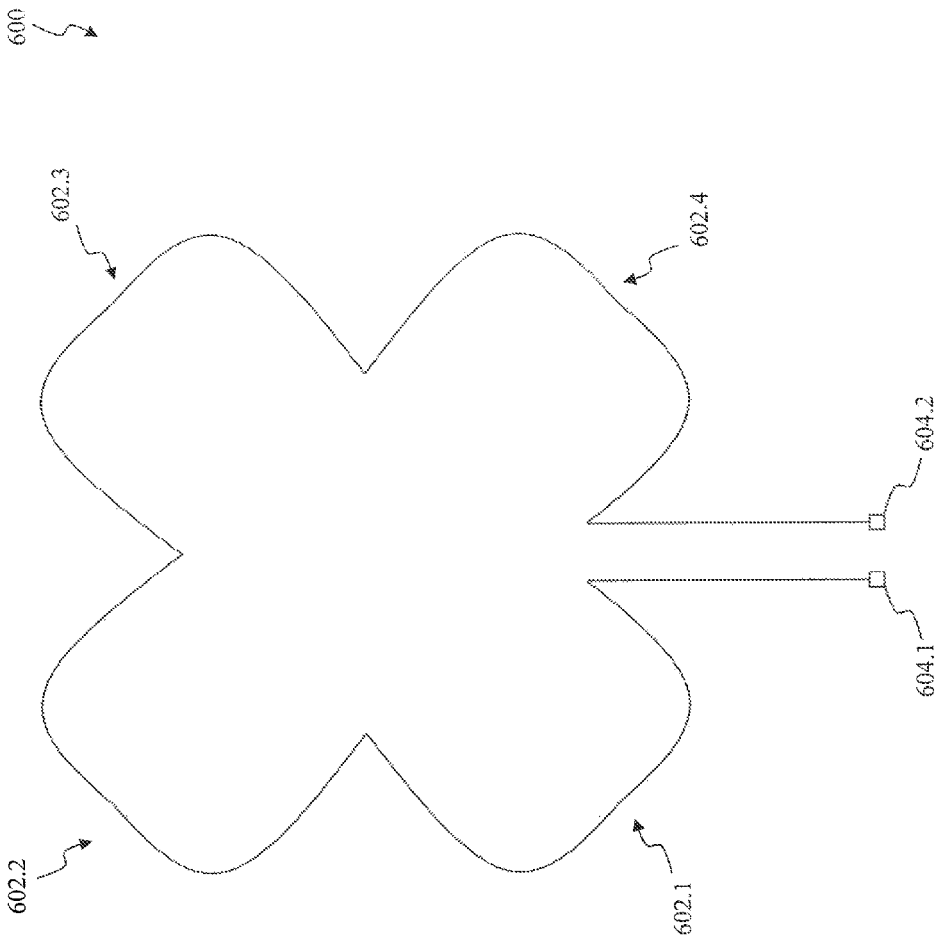


FIG. 6

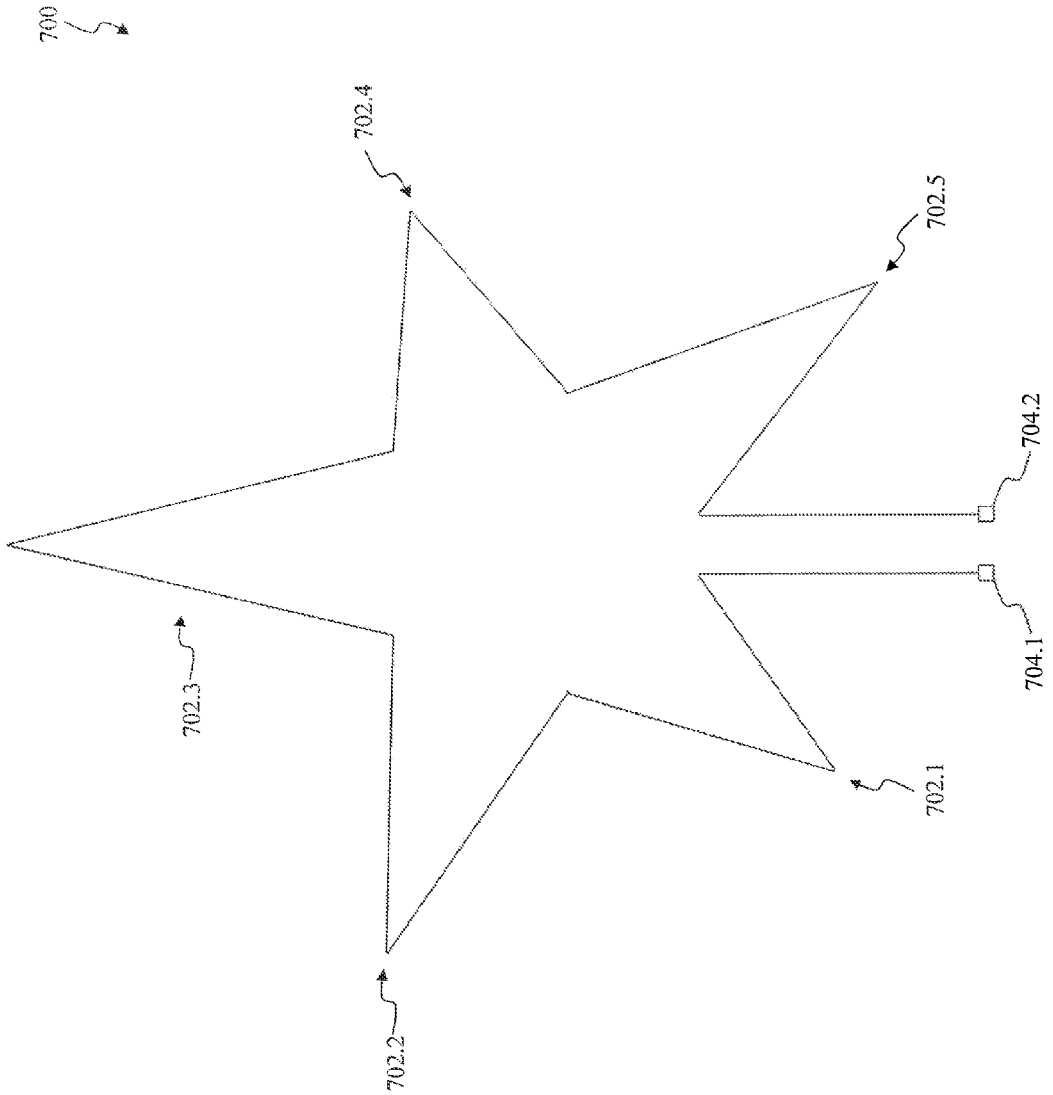
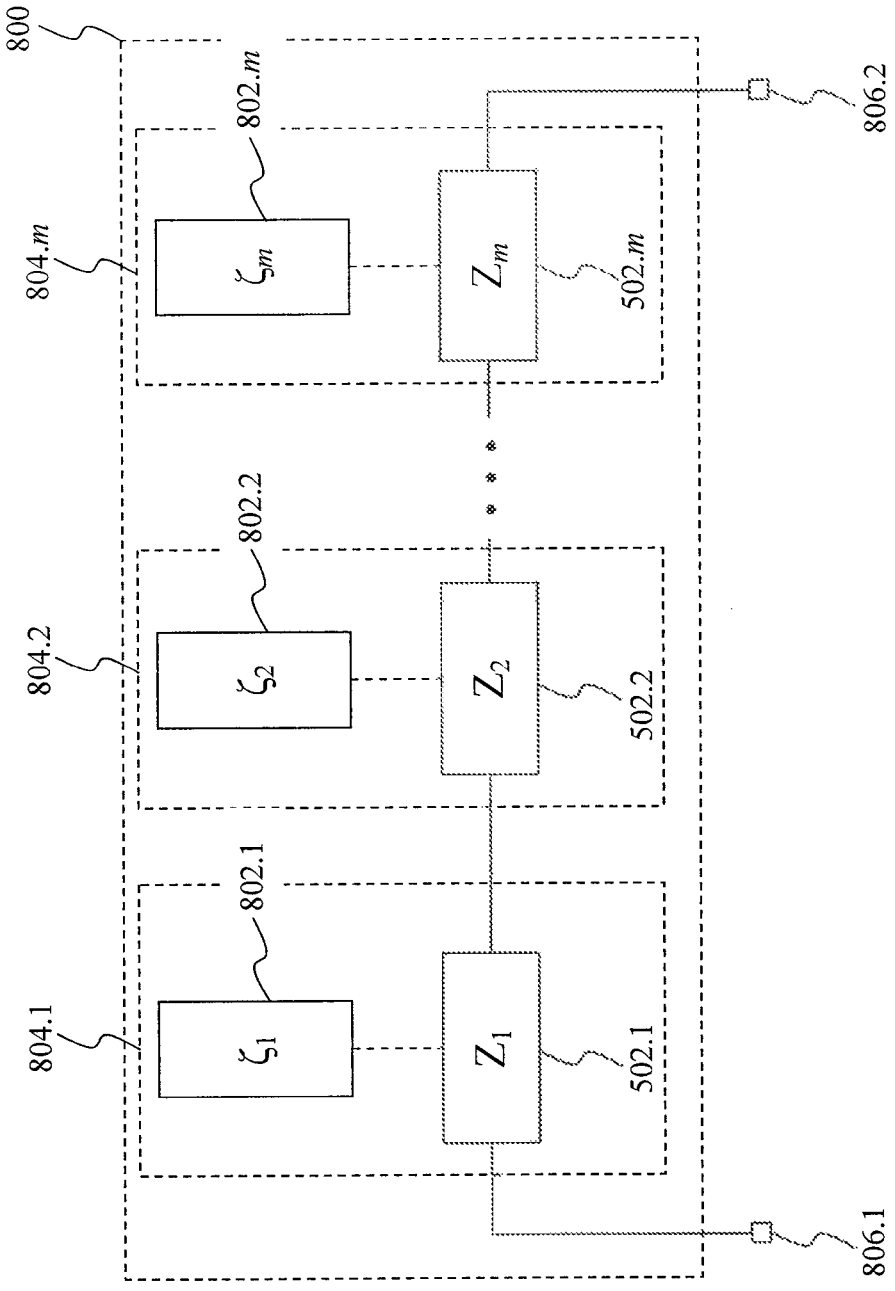


FIG. 7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Z_2
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ζ_1
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502.1
806.1

FIG. 8A

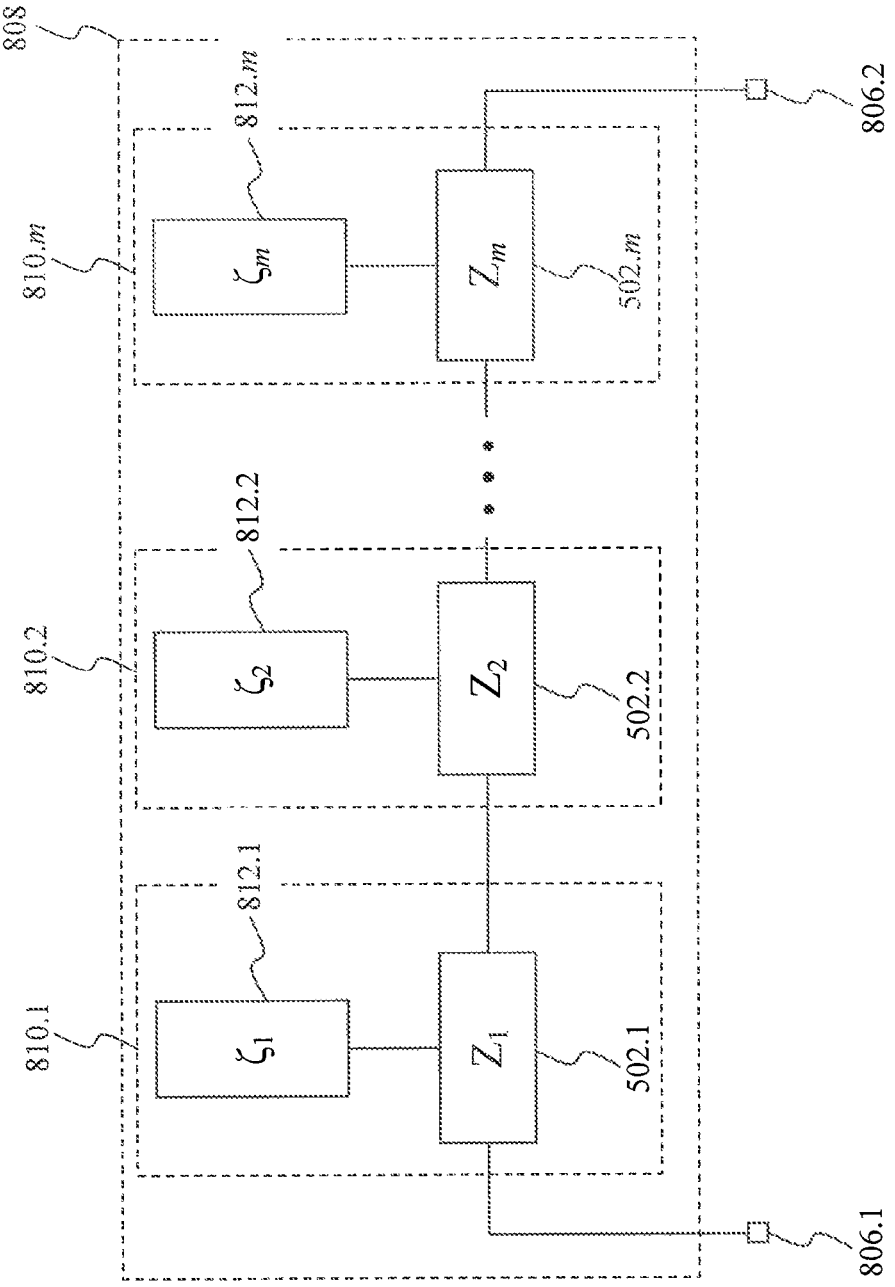
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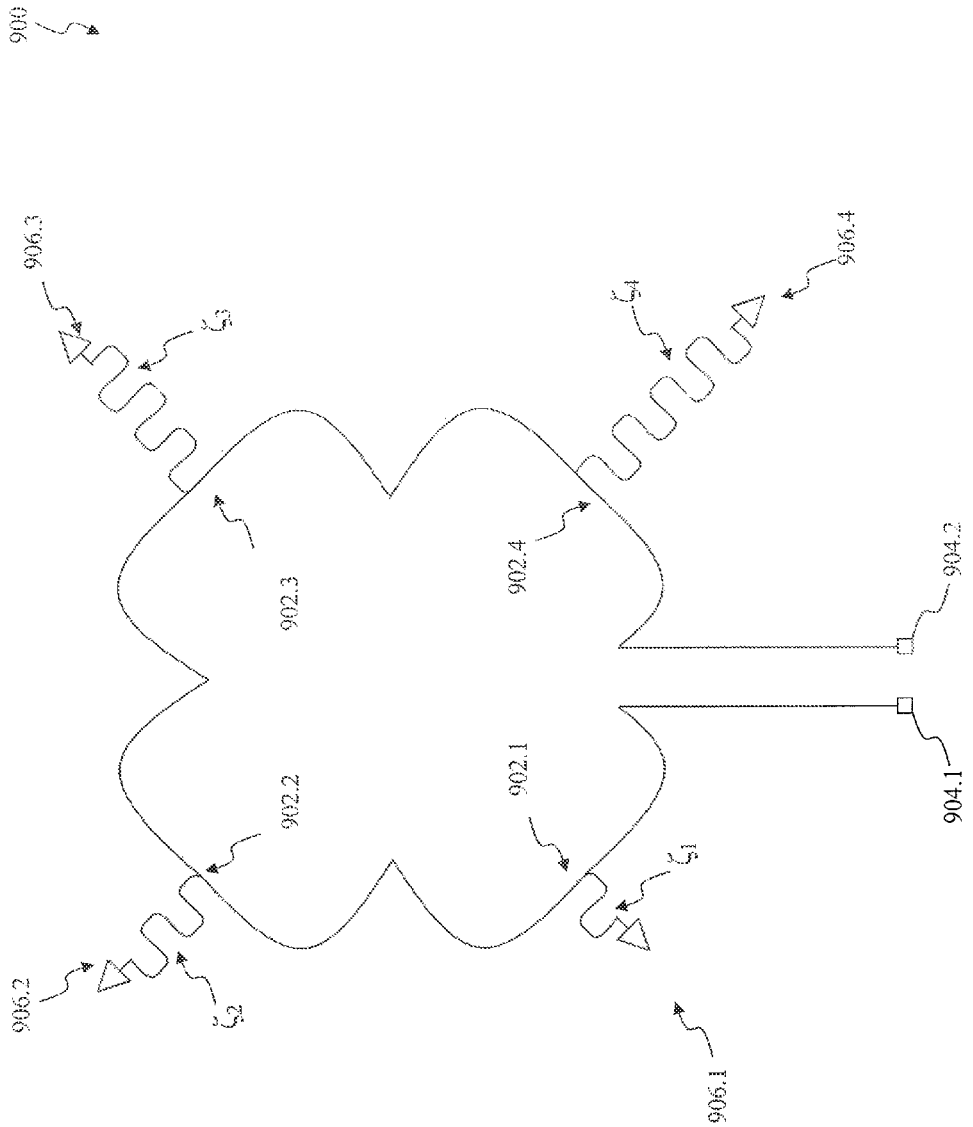
FIG. 8B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S4
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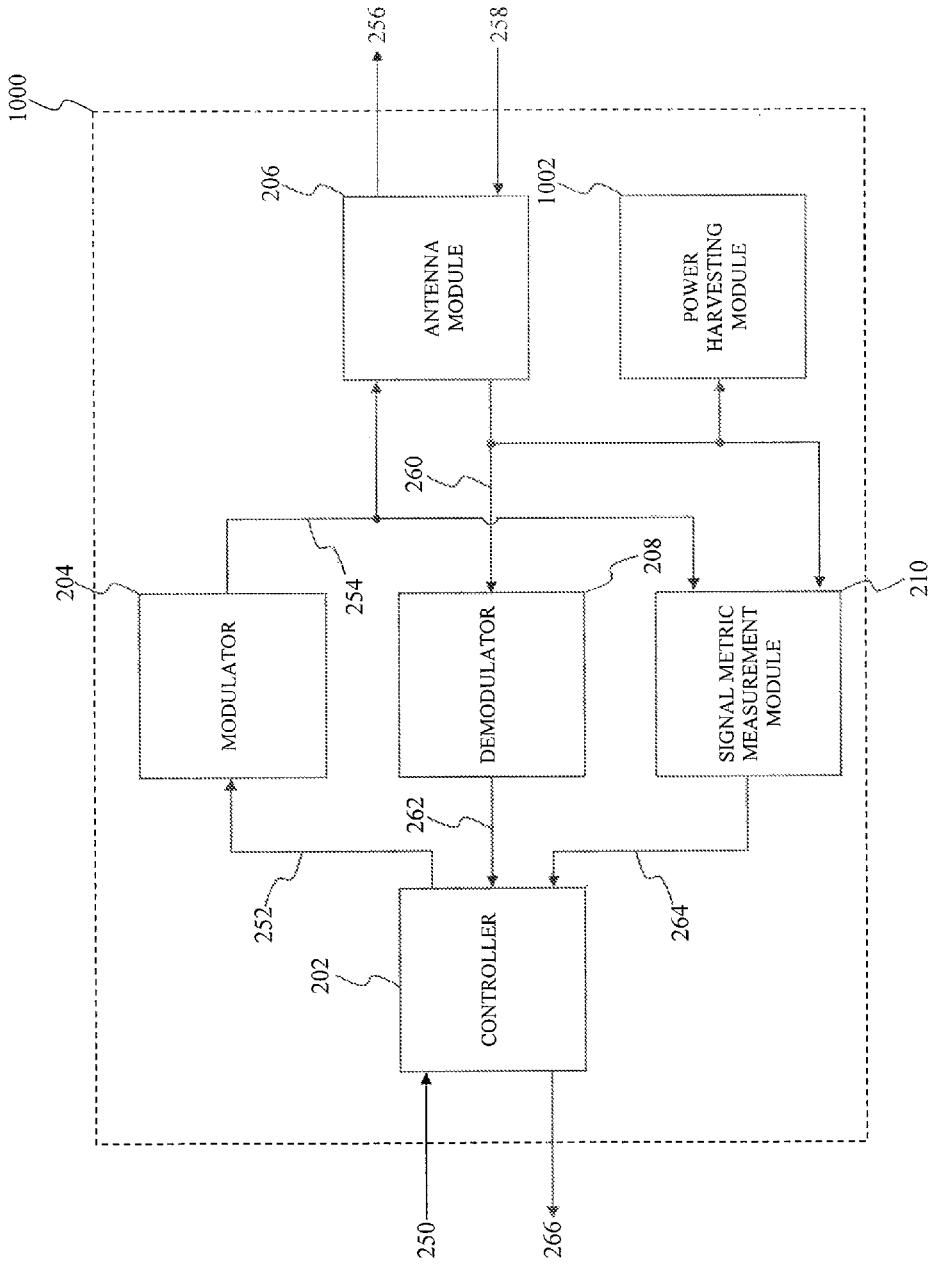
S2
S1
906.1

FIG. 9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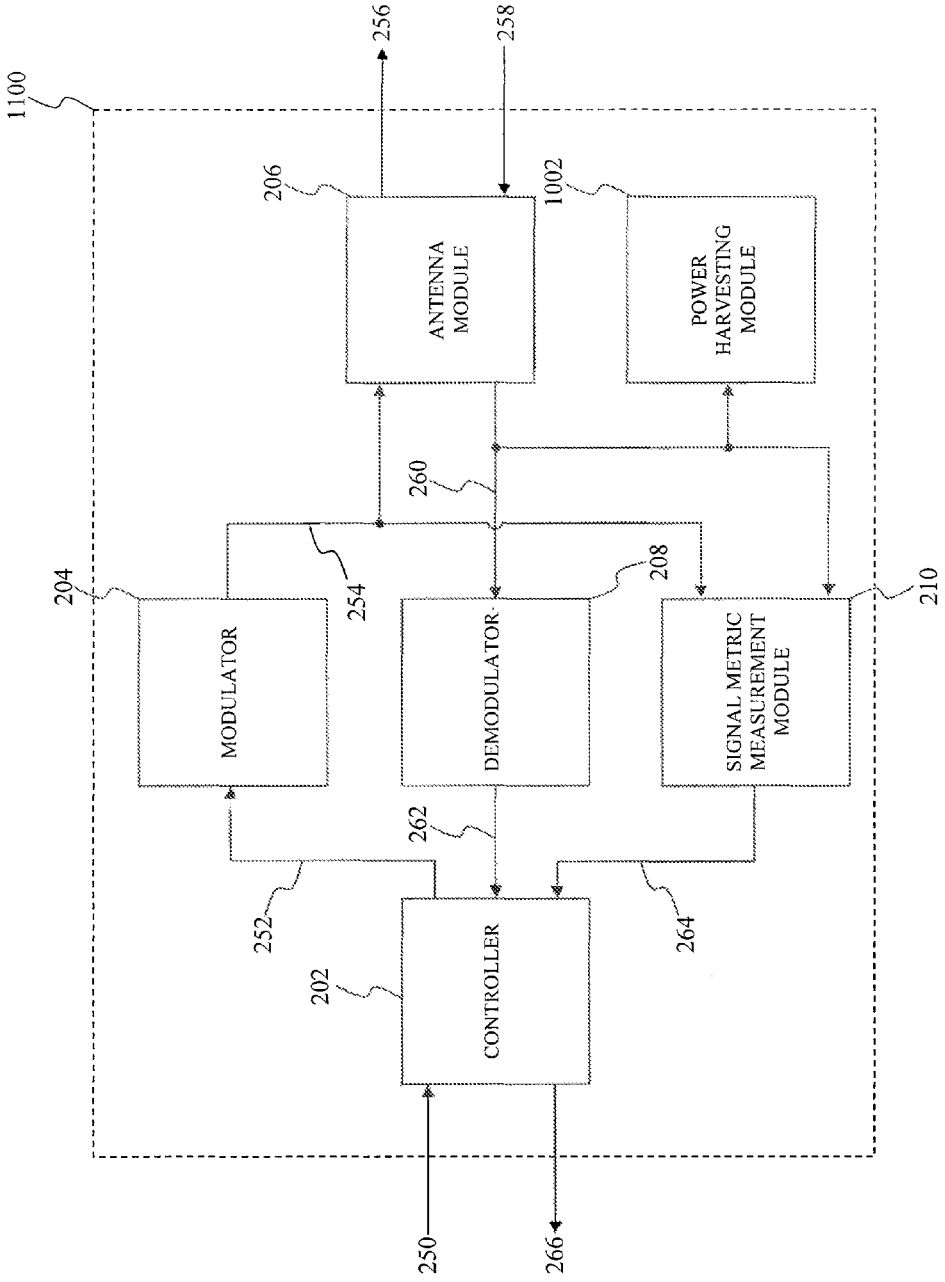
256
258
206
ANTENNA MODULE
1002
POWER HARVESTING MODULE
260
204
254
208
210
MODULATOR
DEMODULATOR
SIGNAL METRIC MEASUREMENT MODULE
262
252
264
202
CONTROLLER
250
266

FIG. 10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MODULATOR
DEMODULATOR
SIGNAL METRIC MEASUREMENT MODULE
262
252
264
202
CONTROLLER
250
266

FIG. 11

TOUCHING AN ANTENNA OF A NEAR FIELD COMMUNICATIONS (NFC) DEVICE TO CONTROL ITS OPERATION

BACKGROUND

1. Field of Invention

The invention relates to near field communications (NFC), and more specifically to operating and/or controlling a NFC capable device by touching, or being sufficiently proximate, to its antenna.

2. Related Art

Near field communication (NFC) devices are being integrated into communication devices, such as mobile devices to provide an example, to facilitate the use of these communication devices in conducting daily transactions. For example, instead of carrying numerous credit cards, the credit information provided by these credit cards could be stored onto a NFC device. The NFC device is simply tapped to a credit card terminal to relay the credit information to it to complete a transaction. As another example, a ticketing writing system, such as those used in bus and train terminals, may simply write ticket fare information onto the NFC device instead of providing a ticket to a passenger. The passenger simply taps the NFC device to a reader to ride the bus or the train without the use of a paper ticket.

Generally, NFC requires that NFC devices to be present within a relatively small distance from one another so that their corresponding magnetic fields can exchange information. Typically, a first NFC device transmits or generates a magnetic field modulated with the information, such as the credit information or the ticket fare information. This magnetic field inductively couples the information onto a second NFC device that is proximate to the first NFC device. The second NFC device may respond to the first NFC device by inductively coupling its corresponding information onto the first NFC device.

Operation of the first and the second NFC devices in the manner as described above discharges its internal batteries. Under certain circumstances, a NFC device may have to derive power from the magnetic field of another NFC device when its internal batteries become too depleted. However, this magnetic field cannot provide adequate power for a user interface of the NFC device. For example, this magnetic field cannot provide adequate power to operate a touch-screen of a communication device into which a NFC is incorporated. Consequently, the operator of the communication device will no longer be able to operate and/or control the NFC device to conduct daily transactions unless its internal batteries are recharged.

Thus, there is a need for a way operate and/or control a NFC device when its internal batteries are so depleted that they cannot provide adequate power for operating a user interface. Further aspects and advantages of the invention will become apparent from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

Embodiments of the invention are described with reference to the accompanying drawings. In the drawings, like reference numbers indicate identical or functionally similar elements. Additionally, the left most digit(s) of a reference number identifies the drawing in which the reference number first appears.

FIG. **1** illustrates a block diagram of a NFC environment according to an exemplary embodiment of the invention;

FIG. **2** illustrates a block diagram of a first NFC device that is implemented as part of the NFC environment according to an exemplary embodiment of the invention;

FIG. **3** graphically illustrates a first operation of the controller module to associate antenna components that have been touched by, or are sufficiently proximate to, the operator with information according to an exemplary embodiment of the invention;

FIG. **4** graphically illustrates a second operation of the controller module to associate the antenna components that have been touched by, or are sufficiently proximate to, the operator with information according to an exemplary embodiment of the invention;

FIG. **5** illustrates a first block diagram of an antenna element that is implemented as part of the antenna module according to an exemplary embodiment of the invention;

FIG. **6** illustrates a first symmetrical configuration of the antenna element according to an exemplary embodiment of the invention;

FIG. **7** illustrates an asymmetrical configuration of the antenna element according to an exemplary embodiment of the invention;

FIG. **8**A illustrates a second block diagram of the antenna element that is implemented as part of the antenna module according to a first exemplary embodiment of the invention;

FIG. **8**B illustrates the second block diagram of the antenna element that is implemented as part of the antenna module according to a second exemplary embodiment of the invention;

FIG. **9** illustrates a second configuration of the antenna element according to an exemplary embodiment of the invention;

FIG. **10** illustrates a block diagram of a second NFC device that is implemented as part of the NFC environment according to an exemplary embodiment of the invention; and

FIG. **11** illustrates a block diagram of a third NFC device that is implemented as part of the NFC environment according to an exemplary embodiment of the invention.

The invention will now be described with reference to the accompanying drawings. In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements. The drawing in which an element first appears is indicated by the leftmost digit(s) in the reference number.

DETAILED DESCRIPTION OF THE INVENTION

The following Detailed Description refers to accompanying drawings to illustrate exemplary embodiments consistent with the invention. References in the Detailed Description to "one exemplary embodiment," "an exemplary embodiment," "an example exemplary embodiment," etc., indicate that the exemplary embodiment described may include a particular feature, structure, or characteristic, but every exemplary embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same exemplary embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an exemplary embodiment, it is within the knowledge of those skilled in the relevant art(s) to affect such feature, structure, or characteristic in connection with other exemplary embodiments whether or not explicitly described.

The exemplary embodiments described herein are provided for illustrative purposes, and are not limiting. Other exemplary embodiments are possible, and modifications may be made to the exemplary embodiments within the spirit and

scope of the invention. Therefore, the Detailed Description is not meant to limit the invention. Rather, the scope of the invention is defined only in accordance with the following claims and their equivalents.

Embodiments of the invention may be implemented in hardware, firmware, software, or any combination thereof. Embodiments of the invention may also be implemented as instructions stored on a machine-readable medium, which may be read and executed by one or more processors. A machine-readable medium may include any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computing device). For example, a machine-readable medium may include read only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; electrical, optical, acoustical or other forms of propagated signals (e.g., carrier waves, infrared signals, digital signals, etc.), and others. Further, firmware, software, routines, instructions may be described herein as performing certain actions. However, it should be appreciated that such descriptions are merely for convenience and that such actions in fact result from computing devices, processors, controllers, or other devices executing the firmware, software, routines, instructions, etc.

The following Detailed Description of the exemplary embodiments will so fully reveal the general nature of the invention that others can, by applying knowledge of those skilled in relevant art(s), readily modify and/or adapt for various applications such exemplary embodiments, without undue experimentation, without departing from the spirit and scope of the invention. Therefore, such adaptations and modifications are intended to be within the meaning and plurality of equivalents of the exemplary embodiments based upon the teaching and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by those skilled in relevant art(s) in light of the teachings herein.

Although the description of the present invention is to be described in terms of NFC, those skilled in the relevant art(s) will recognize that the present invention may be applicable to other communications that use the near field and/or the far field without departing from the spirit and scope of the present invention. For example, although the present invention is to be described using NFC capable communication devices, those skilled in the relevant art(s) will recognize that functions of these NFC capable communication devices may be applicable to other communications devices that use the near field and/or the far field without departing from the spirit and scope of the present invention.

An Exemplary Near Field Communications (NFC) Environment

FIG. **1** illustrates a block diagram of a NFC environment according to an exemplary embodiment of the invention. A NFC environment **100** provides wireless communication of information, such as one or commands and/or data, among a first NFC device **102** and a second NFC device **104** that are sufficiently proximate to each other. The first NFC device **102** and/or the second NFC device **104** may be implemented as a standalone or a discrete device or may be incorporated within or coupled to another electrical device or host device such as a mobile telephone, a portable computing device, another computing device such as a personal, a laptop, or a desktop computer, a computer peripheral such as a printer, a portable audio and/or video player, a payment system, a ticketing writing system such as a parking ticketing system, a bus ticketing system, a train ticketing system or an entrance ticketing system to provide some examples, or in a ticket reading system, a toy, a game, a poster, packaging, advertising material, a product inventory checking system and/or any other suitable electronic device that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention.

Conventionally, an operator may operate and/or control the first NFC device **102** and/or the second NFC device **104** using a user interface, such as a touch-screen display, an alphanumeric keypad, a microphone, a mouse, a speaker, any other suitable user interface that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention, or any combination thereof. The user interface may be configured to allow the operator to provide information, such as data and/or one or more commands to provide some examples, to the first NFC device **102** and/or the second NFC device **104**. Herein, information includes data that is to be transferred from a first NFC capable device to a second NFC capable device, data that is to be stored or used by the first NFC capable device and/or the second NFC capable device, data that is to be provided to the first NFC capable device and/or the second NFC capable device, data that is to be provided to an operator of the first NFC capable device and/or the second NFC capable device, or any combination thereof. Herein, a NFC capable device refers to an electrical device or host device that is integrated with a NFC device or the NFC device itself.

The information may also include one or more commands to be executed by the first NFC capable device and/or the second NFC capable device. The user interface may be configured to provide the information from the first NFC device **102** and/or the second NFC device **104** to the operator.

The operator may also operate and/or control the first NFC device **102** and/or the second NFC device **104** by touching, or being sufficiently proximate to, antenna components of a first antenna of the first NFC device **102** and/or antenna components of a second antenna of the second NFC device **104**, respectively. This mode of operation is particularly useful when there is insufficient internal battery power available to provide sufficient power to the user interface. This mode of operation is also useful when the first NFC device **102** and/or the second NFC device **104** rely on power harvested from a communication signal to operate.

The operator may physically touch, such as a touch from a finger or a hand of the operator and/or a touch from other passive objects available to the operator such as a stylus to provide some examples, the antenna components of the first antenna and/or the second antenna to cause a change in a characteristic impedance of the antenna. The operator may be sufficiently proximate to the antenna components of the first antenna and/or the second antenna to cause the change in the characteristic impedance of the antenna. Touching of, or being sufficiently proximate to, the antenna components of the first antenna and/or the second antenna enable the operator to provide information to the first NFC device **102** and/or the second NFC device.

The first NFC device **102** and/or the second NFC device **104** interact with each other to exchange the information, in a peer (P2P) communication mode or a reader/writer (R/W) communication mode. In the P2P communication mode, the first NFC device **102** and the second NFC device **104** may be configured to operate according to an active communication mode and/or a passive communication mode. The first NFC device **102** modulates its corresponding information onto a first carrier wave, referred to as a modulated information communication, and generates a first magnetic field by apply-

ing the modulated information communication to the first antenna to provide a first information communication **152**. The first NFC device **102** ceases to generate the first magnetic field after transferring its corresponding information to the second NFC device **104** in the active communication mode. Alternatively, in the passive communication mode, the first NFC device **102** continues to apply the first carrier wave without its corresponding information, referred to as an unmodulated information communication, to continue to provide the first information communication **152** once the information has been transferred to the second NFC device **104**.

The first NFC device **102** is sufficiently proximate to the second NFC device **104** such that the first information communication **152** is inductively coupled onto a second antenna of the second NFC device **104**. The second NFC device **104** demodulates the first information communication **152** to recover the information. The second NFC device **104** may respond to the information by modulating its corresponding information onto a second carrier wave and generating a second magnetic field by applying this modulated information communication to the second antenna to provide a second modulated information communication **154** in the active communication mode. Alternatively, the second NFC device **104** may respond to the information by modulating the second antenna with its corresponding information to modulate the first carrier wave to provide the second modulated information communication **154** in the passive communication mode.

In the R/W communication mode, the first NFC device **102** is configured to operate in an initiator, or reader, mode of operation and the second NFC device **104** is configured to operate in a target, or tag, mode of operation. However, this example is not limiting, those skilled in the relevant art(s) will recognize that the first NFC device **102** may be configured to operate in the tag mode and the second NFC device **104** may be configured to operate as in the reader mode in accordance with the teachings herein without departing from the spirit and scope of the present invention. The first NFC device **102** modulates its corresponding information onto the first carrier wave and generates the first magnetic field by applying the modulated information communication to the first antenna to provide the first information communication **152**. The first NFC device **102** continues to apply the first carrier wave without its corresponding information to continue to provide the first information communication **152** once the information has been transferred to the second NFC device **104**. The first NFC device **102** is sufficiently proximate to the second NFC device **104** such that the first information communication **152** is inductively coupled onto a second antenna of the second NFC device **104**.

The second NFC device **104** derives or harvests power from the first information communication **152** to recover, to process, and/or to provide a response to the information. The second NFC device **104** demodulates the first information communication **152** to recover and/or to process the information. The second NFC device **104** may respond to the information by modulating the second antenna with its corresponding information to modulate the first carrier wave to provide the second modulated information communication.

Further operations of the first NFC device **102** and/or the second NFC device **104** may be described in International Standard ISO/IE 18092:2004(E), "Information Technology—Telecommunications and Information Exchange Between Systems—Near Field Communication—Interface and Protocol (NFCIP-1)," published on Apr. 1, 2004 and International Standard ISO/IE 21481:2005(E), "Information Technology—Telecommunications and Information Exchange Between Systems—Near Field Communication—Interface and Protocol-2 (NFCIP-2)," published on Jan. 15, 2005, each of which is incorporated by reference herein in its entirety.

A First Exemplary NFC Device

FIG. **2** illustrates a block diagram of a first NFC device that is implemented as part of the NFC environment according to an exemplary embodiment of the invention. A NFC device **200** is configured to operate in a reader mode of operation to initiate an exchange of information, such as data and/or one or more commands to provide some examples, with other NFC devices. An operator may operate and/or control the NFC device **200** using a user interface and/or may touch, or be sufficiently proximate to, an antenna module of the NFC device **200**. For example, the operator may provide information to the NFC device **200** by touching, or being sufficiently proximate to, the antenna module. The NFC device **200** includes a controller module **202**, a modulator module **204**, an antenna module **206**, a demodulator module **208**, and a signal metric measurement module **210**. The NFC device **200** may represent an exemplary embodiment of the first NFC device **102** and/or the second NFC device **104**.

The controller module **202** controls overall operation and/or configuration of the NFC device **200**. The controller module **202** receives information **250** from one or more data storage devices such as one or more contactless transponders, one or more contactless tags, one or more contactless smartcards, any other machine-readable mediums that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention, or any combination thereof. The other machine-readable medium may include, but is not limited to, read only memory (ROM), random access memory (RAM), magnetic disk storage media, optical storage media, flash memory devices, electrical, optical, acoustical or other forms of propagated signals such as carrier waves, infrared signals, digital signals to provide some examples. The controller module **202** may also receive the information **250** from a user interface such as a touch-screen display, an alphanumeric keypad, a microphone, a mouse, a speaker, any other suitable user interface that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention to provide some examples. The controller module **202** may further receive the information **250** from other electrical devices or host devices coupled to the NFC device **200**.

Typically, the controller module provides the information **250** as transmission information **252** for transmission to another NFC capable device. However, the controller module **202** may also use the information **250** to control the overall operation and/or configuration of the NFC device **200**. For example, the controller module **202** may issue and/or execute the one or more commands in accordance with the data, if appropriate, to control operations of the NFC device **200**, such as a transmission power, a transmission data rate, a transmission frequency, a modulation scheme, a bit and/or a byte encoding scheme and/or any other suitable operation parameter that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention, of other NFC capable devices.

Additionally, the controller module **202** may format the information **250** into information frames and may perform error encoding, such as cyclic redundancy check (CRC) to provide an example, on the information frames to provide the transmission information **252**. The information frames may include frame delimiters to indicate a start and/or an end of each of the information frames. The controller module **202** may additionally arrange multiple information frames to

form sequences of information frames to synchronize and/or to calibrate the NFC device **200** and/or another NFC capable device. The sequences may include sequence delimiters to indicate a start and/or an end of each of the sequences.

Further, the controller module **202** may perform other functionality as described in International Standard ISO/IE 18092:2004(E), "Information Technology—Telecommunications and Information Exchange Between Systems—Near Field Conmmunication—Interface and Protocol (NFCIP-1)," published on Apr. 1, 2004 and International Standard ISO/IE 21481:2005(E), "Information Technology—Telecommunications and Information Exchange Between Systems—Near Field Communication—Interface and Protocol-2 (NFCIP-2)," published on Jan. 15, 2005, each of which is incorporated by reference herein in its entirety.

The modulator module **204** modulates the transmission information **252** onto a carrier wave, such as a radio frequency carrier wave having a frequency of approximately 13.56 MHz to provide an example, using any suitable analog or digital modulation technique to provide a modulated information communication as transmission information **254**. The suitable analog or digital modulation technique may include amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), phase shift keying (PSK), frequency shift keying (FSK), amplitude shift keying (ASK), quadrature amplitude modulation (QAM) and/or any other suitable modulation technique that will be apparent to those skilled in the relevant art(s). The modulator module **204** may continue to provide the carrier wave to provide an unmodulated information communication as the transmission information **254** once the transmission information **252** has been transferred to another NFC capable device. Alternatively, the modulator module **204** may cease to provide the transmission information **254** once the transmission information **252** has been transferred to another NFC capable device

The antenna module **206** applies the transmission information **254** to an inductive coupling element, such as a resonant tuned circuit to provide an example, to generate a magnetic field to provide a transmitted information communication **256**. Additionally, another NFC capable device may inductively couple a received communication signal **258** onto the inductive coupling element to provide a recovered communication signal **260**. For example, this other NFC capable device may respond to the information by modulating its corresponding antenna with its corresponding information to modulate the carrier wave to provide the received communication signal **258**. As another example, this other NFC capable device may modulate its corresponding information onto its corresponding carrier wave and generate its corresponding magnetic field by applying this modulated information communication to its corresponding antenna to provide the received communication signal **258**.

The demodulator module **208** demodulates the recovered communication signal **260** using any suitable analog or digital modulation technique to provide reception information **262**. The suitable analog or digital modulation technique may include amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), phase shift keying (PSK), frequency shift keying (FSK), amplitude shift keying (ASK), quadrature amplitude modulation (QAM) and/or any other suitable modulation technique that will be apparent to those skilled in the relevant art(s).

Typically, the controller mode provides the reception information **262** as recovered information **266** to the data store, the user interface, and/or other electrical devices or host devices. However, the controller module **202** may also use the reception information **262** to control the overall operation and/or configuration of the NFC device **200**. The reception information **262** may include one or more commands and/or data. The controller module **202** may issue and/or execute the one or more commands to control the overall operation and/or configuration of the NFC device **200**. For example, the controller module **202** may issue and/or execute the one or more commands in accordance with the data, if appropriate, to control operations of the NFC device **200**, such as a transmission power, a transmission data rate, a transmission frequency, a modulation scheme, a bit and/or a byte encoding scheme and/or any other suitable operation parameter that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention, of other NFC capable devices.

Additionally, the controller module **202** formats the reception information **262** into a suitable format for transmission to the data store, the user interface, and/or other electrical devices or host devices, and may perform error decoding, such as cyclic redundancy check (CRC) decoding to provide an example, on the reception information **262** to provide recovered information **266**.

The antenna module **206** may be additionally used to operate and/or control the NFC device **200**. For example, the operator may touch, or be sufficiently proximate to, antenna components of the antenna module **206** to operate and/or control the NFC device **200**. The antenna module **206** includes one or more antenna components that are configured and arranged to form the inductive coupling element. The operator's touching of, or sufficient proximity to, the antenna module **206** causes a change in at least one characteristic impedance of at least one antenna component. This change in characteristic impedance causes a change in one or more signal metrics of the transmission information **254** and/or the recovered communication signal **260**. For example, the one or more signal metrics may change from a corresponding first signal metric to a corresponding second signal metric in response to the operator touching, or being sufficiently proximate to, the antenna module **206**.

The signal metric measurement module **210** determines one or more signal metrics **264** of the transmission information **254** and/or the recovered communication signal **260**. The one or more signal metrics **264** may include a mean voltage and/or current level, an average voltage and/or current level, an instantaneous voltage and/or current level, a root mean square voltage and/or current level, a mean power, an average power, an instantaneous power, a root mean square power, a frequency, a phase and/or any other suitable signal metric of the transmission information **254** and/or the recovered communication signal **260** which will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention. Alternatively, the one or more signal metrics **264** may include one or more network parameters of the transmission information **254** and/or the recovered communication signal **260** such as one or more scattering parameters, commonly referred to a S-parameters, one or more admittance parameters, commonly referred to a Y-parameters, one or more impedance parameters, commonly referred to a Z-parameters, one or more scattering transfer parameters, commonly referred to as T-parameters, one or more nonlinear network parameters, commonly referred to as X-parameters, and/or any other suitable network parameter of the transmission information **254** and/or the recovered communication signal **260** which will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the invention.

The controller module **202** determines a location of the antenna components that have been touched by, or are suffi-

ciently proximate to, the operator based upon the one or more signal metrics **264** and associates the antenna components that have been touched by, or are sufficiently proximate to, the operator with information as to be discussed below.

Exemplary Operation of the Controller Module that is Implemented as Part of the First Exemplary NFC Device

FIG. **3** graphically illustrates a first operation of the controller module to associate antenna components that have been touched by, or are sufficiently proximate to, the operator with information according to an exemplary embodiment of the invention. The controller module **202** associates the antenna components that have been touched by, or are sufficiently proximate to, the operator with information such as one or more commands and/or data.

The controller module **202** compares the one or more signal metrics **264** to one or more previous signal metrics to determine a change in the one or more signal metrics **300**. The one or more previous signal metrics may represent one or more predetermined signal metrics of the transmission information **254** and/or the recovered communication signal **260** that have been determined by the signal metric measurement module **210** without the operator touching, or being sufficiently proximate to, the antenna components of the antenna module **206**. Alternatively, the one or more previous signal metrics may represent one or more signal metrics of the transmission information **254** and/or the recovered communication signal **260** that were previously determined by signal metric measurement module **210**. In another alternate, a manufacturer may determine the one or more previous signal metrics and/or the signal metric changes, or the signal metric ranges of changes, for each of the antenna components of the antenna module **206** which are then stored in a look-up table by the controller module **202** and/or the data store module at a time of manufacture. The manufacturer may determine a unique look-up table for a specific NFC device and/or may determine a generic look-up table for a series or family of NFC devices. This generic look-up table may be adapted by the operator for a specific NFC device that is being used by the operator and/or for other specific operator parameters, such as a size of the operator's hands to provide an example, using a calibration process.

The controller module **202** matches the change in the one or more signal metrics **300** with a corresponding signal metric change **302**.**1** through **302**.N. Each of the signal metric changes **302**.**1** through **302**.N may represent an expected change in the one or more signal metrics **300**. The controller module **202** matches the change in the one or more signal metrics **300** that is closest to the expected change to determine a corresponding signal metric change **302**.**1** through **302**.N. Alternatively, each of the signal metric changes **302**.**1** through **302**.N may represent a range of expected changes in the one or more signal metrics **302**. The controller module **202** matches the change in the one or more signal metrics **300** that is within to the expected range of changes to determine a corresponding signal metric change **302**.**1** through **302**.N.

The controller module **202** associates the corresponding signal metric change **302**.**1** through **302**.N with a corresponding antenna component **304**.**1** through **304**.N to determine a location of the antenna components that have been touched by, or are sufficiently proximate to, the operator. For example, the controller module **202** associates the signal metric change **302**.**1** with the antenna component **304**.**1** to determine that the operator has touched, or is sufficiently proximate to, the antenna component **304**.**1**.

The controller module **202** associates the corresponding antenna component **304**.**1** through **304**.N with corresponding information **306**.**1** through **306**.N. The corresponding information **306**.**1** through **306**.N may represent possible information that may such as one or more commands and/or data. For example, the controller module **202** may associate the corresponding antenna component **304**.**1** with one or more commands to write data to another NFC capable device and/or one or more commands to read data from another NFC capable device. In this situation, the controller module **202** may execute the one or more commands to write data and/or to read data when the operator has touched, or is sufficiently proximate to, the antenna component **304**.**1**. As another example, the controller module **202** may associate the corresponding antenna component **304**.**1** with one or more commands to execute a transaction. In this situation, the controller module **202** may execute the one or more commands to execute the transaction when the operator has touched, or is sufficiently proximate to, the antenna component **304**.**1**. As a further example, the controller module **202** may associate the corresponding antenna component **304**.**1** through **304**.N with data corresponding to one or more alphanumeric characters. Typically, the one or more alphanumeric characters include numbers 0 to 9, letters A to Z, and/or any other suitable character or symbol that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the present invention.

FIG. **4** graphically illustrates a second operation of the controller module to associate the antenna components that have been touched by, or are sufficiently proximate to, the operator with information according to an exemplary embodiment of the invention. The controller module **202** is configured to determine whether changes in the one or more signal metrics **264** result from one or more antenna components being touched by, or being sufficiently proximate to, the operator or result from another NFC capable device entering into the magnetic field generated by the NFC device **200**. The second operation shares many substantially similar features to the first operation as described in FIG. **3**; therefore, only differences between these two operations are to be discussed in further detail.

As shown in FIG. **4**, one of the signal metric changes **302**.**1** through **302**.N is associated with a presence of another NFC capable device entering into the magnetic field generated by the NFC device **200**. The controller module **202** may detect the presence of this other NFC capable device when the change in the one or more signal metrics **300** corresponds to the signal metric change **302**.**1**.

Exemplary Antenna Elements that are Implemented as Part of the First Exemplary NFC Device

FIG. **5** illustrates a first block diagram of an antenna element that is implemented as part of the antenna module according to an exemplary embodiment of the invention. An antenna element **500** may generate a magnetic field to provide a transmitted information communication, such as the transmitted information communication **256** to provide an example. Other NFC capable devices may inductively couple a received communication signal, such as the received communication signal **258** to provide an example, onto the antenna element **500**. Additionally, an operator may operate and/or control a NFC device, such as the first NFC device **102**, the second NFC device **104**, and/or the NFC device **200** to provide some examples, by touching, or being sufficiently proximate to, the antenna element **500**. The antenna element **500** may represent an exemplary embodiment of the antenna module **206**.

The antenna element **500** includes antenna components **502**.**1** through **502**.*m* that are configured and arranged in series with each other. For example, the antenna component **502**.**1** is coupled to the antenna component **502**.**2**. The

antenna component **502.1** is further coupled to a first connection **504.1** and the antenna component **502.*m*** is further coupled to a second connection **504.2**. Alternatively, each of the antenna components **502.1** through **502.*m*** may be configured and arranged to be parallel with each other. In another alternative, a first group of the antenna components **502.1** through **502.*m*** may be configured and arranged in series with each other and a second group of the antenna components **502.1** through **502.*m*** may be configured and arranged to be parallel with each other.

Generally, each of the antenna components **502.1** through **502.*m*** is implemented using any regular and/or irregular open geometric shape that will be apparent to those skilled in the relevant art(s) without departing from the spirit and scope of the present invention. Each of the antenna components **502.1** through **502.*m*** may be symmetric, as shown in FIG. **6** to each other and/or asymmetric from each other as shown in FIG. **7**; therefore, the characteristic impedances Z_1 through Z_m may also be similar to each other and/or dissimilar from each other.

Additionally, as shown in FIG. **5**, each of the antenna components **502.1** through **502.*m*** is characterized having a corresponding characteristic impedance from among characteristic impedances Z_1 through Z_m. In an exemplary embodiment, adjacent antenna components from among the antenna components **502.1** through **502.*m*** are configured to have different characteristic impedances.

The operator may touch, or be sufficiently proximate to, one or more of the antenna components **502.1** through **502.*m*** to operate and/or control the NFC device. For example, the operator may touch one or more of the antenna components **502.1** through **502.*m*** using a finger or a hand or through other passive objects available to the operator such as a stylus to provide an example. The operator's touching of, or sufficient proximity to, the antenna components **502.1** through **502.*m*** causes a change in one or more of the characteristic impedances Z_1 through Z_m that correspond to the one or more of the antenna components **502.1** through **502.*m*** that have been touched, or are sufficiently proximate to, the operator. For example, the operator's touching of, or sufficient proximity to, the antenna component **502.1** may cause the characteristic impedance Z_1 to change from a first characteristic impedance to a second characteristic impedance.

The antenna element **500** may represent an inductor or coil of wire that is placed within the NFC capable device. For example, the antenna element **500** may be placed in a mechanical housing of the NFC capable device allowing the operator to touch, or be sufficiently proximate to, the mechanical housing to operate and/or control the NFC capable device. Typically, the antenna element **500** is positioned on a different side of the mechanical housing from the user interface, such as a side of the mechanical housing that is opposite of the user interface to provide an example. Alternatively, the antenna element **500** may be formed using a transparent conductor, such as indium tin oxide to provide an example, and integrated into the user interface. In another alternate, the antenna element **500** may represent a printed circuit that is formed onto a printed circuit substrate. In a further alternate, the antenna element **500** may be formed onto one or more semiconductor chips or dies using a semiconductor photolithographic process.

FIG. **6** illustrates a first symmetrical configuration of the antenna element according to an exemplary embodiment of the invention. An operator may operate and/or control a NFC device, such as the first NFC device **102**, the second NFC device **104**, and/or the NFC device **200** to provide some examples, by touching, or being sufficiently proximate to, one or more antenna components **602.1** through **602.4** of an antenna element **600**. The antenna element **600** may represent an exemplary embodiment of the antenna element **500**.

As shown in FIG. **6**, the antenna element **600** includes antenna components **602.1** through **602.4** that are configured and arranged in series with each other. However this example is not limiting, those skilled in the relevant art(s) will recognize that the antenna element **600** may include more or less antenna components without departing from the spirit and scope of the invention. The antenna component **602.1** is further coupled to a first connection **604.1** and the antenna component **602.4** is further coupled to a second connection **604.2**. The antenna components **602.1** through **602.4** may be characterized by a characteristic impedance from among characteristic impedances Z_1 through Z_4.

FIG. **7** illustrates an asymmetrical configuration of the antenna element according to an exemplary embodiment of the invention. An operator may operate and/or control a NFC device, such as the first NFC device **102**, the second NFC device **104**, and/or the NFC device **200** to provide some examples, by touching, or being sufficiently proximate, to antenna components **702.1** through **702.4** of an antenna element **700**. The antenna element **700** may represent an exemplary embodiment of the antenna element **500**.

As shown in FIG. **7**, the antenna element **700** includes antenna components **702.1** through **702.5** configured and arranged in series with each other. However this example is not limiting, those skilled in the relevant art(s) will recognize that the antenna element **700** may include more or less antenna components without departing from the spirit and scope of the invention. The antenna component **702.1** is further coupled to a first connection **704.1** and the antenna component **702.5** is further coupled to a second connection **704.2**.

FIG. **8**A illustrates a second block diagram of an antenna element that is implemented as part of the antenna module according to a first exemplary embodiment of the invention. An antenna element **800** may generate a magnetic field to provide a transmitted information communication, such as the transmitted information communication **256** to provide an example. Other NFC capable devices may inductively couple a received communication signal, such as the received communication signal **258** to provide an example, onto the antenna element **800**. Additionally, an operator may operate and/or control a NFC device, such as the first NFC device **102**, the second NFC device **104**, and/or the NFC device **200** to provide some examples, by touching, or being sufficiently proximate to, the antenna element **800**. The antenna element **800** may represent an exemplary embodiment of the antenna module **206**.

The antenna element **800** includes antenna components **804.1** through **804.*m*** that are configured and arranged in series with each other. For example, the antenna component **804.1** is coupled to the antenna component **804.2**. The antenna component **804.1** is further coupled to a first connection **806.1** and the antenna component **804.*m*** is further coupled to a second connection **806.2**. Alternatively, each of the antenna components **804.1** through **804.*m*** may be configured and arranged to be parallel with each other. In another alternative, a first group of the antenna components **804.1** through **804.*m*** may be configured and arranged in series with each other and a second group of the antenna components **804.1** through **804.*m*** may be configured and arranged to be parallel with each other.

Each of the antenna components **804.1** through **804.*m*** include a corresponding antenna component **502.1** through **502.*m*** that is coupled to a corresponding antenna impedance element **802.1** through **802.*m***. Specifically, the antenna

impedance elements **802.1** through **802**.*m* are indirectly connected to their corresponding antenna component **502.1** through **502**.*m* by an electric field that forms between one of the antenna components **502.1** through **502**.*m* and the operator when the operator touches, or is sufficiently proximate to, one of the antenna impedance elements **804.1** through **804**.*m*. An intensity of this electric field is based upon a corresponding characteristic impedance of the antenna impedance elements **802.1** through **802**.*m*.

Typically, in a symmetric configuration, each of the antenna components **502.1** through **502**.*m* may exhibit substantially similar changes in their corresponding characteristic impedances Z_1 through Z_m when being touched by, or are sufficiently proximate to, the operator. However, each of the antenna impedance elements **802.1** through **802**.*m* may exhibit substantially dissimilar changes in their corresponding characteristic impedances ζ_1 through ζ_m, when being touched by, or are sufficiently proximate to, the operator. As a result, the antenna components **804.1** through **804**.*m* will exhibit substantially dissimilar changes in their corresponding characteristic impedances. However this example is not limiting, those skilled in the relevant art(s) will recognize that the antenna impedance elements **802.1** through **802**.*m* may implemented as part of an asymmetrical configuration without departing from the spirit and scope of the present invention.

Generally, the antenna impedance elements **802.1** through **802**.*m* are implemented using any regular and/or irregular geometric shape that is characterized by a corresponding characteristic impedance from among characteristic impedances ζ_1 through ζ_m. In an exemplary embodiment, the antenna impedance elements **802.1** through **802**.*m* may be characterized as having substantially different characteristic impedances ζ_1 through ζ_m from one another. For example, the antenna impedance element **802.1** is configured and arranged to form a first impedance element that is characterized as having a first number of turns. Likewise, the antenna impedance element **802.2** is configured and arranged to form a second impedance element that is characterized as having a second number of turns, the second number of turns being different from the first number of turns. In an exemplary embodiment, the antenna impedance elements **802.1** through **802**.*m* are configured to be normal to their corresponding antenna components **502.1** through **502**.*m* in three dimensional space such that a performance of the antenna element **800** in sending and/or receiving an information communication is negligibly affected by the antenna impedance elements **802.1** through **802**.

It should be noted that the configuration of the antenna impedance elements **802.1** through **802**.*m* as illustrated in FIG. **8** for illustrative purposes only, those skilled in the relevant art(s) will recognize that the antenna impedance elements **802.1** through **802**.*m* may be oriented in any suitable direction in three dimensional space without departing from the spirit and scope of the present invention. Additionally, those skilled in the relevant art(s) will recognize that each of the antenna impedance elements **802.1** through **802**.*m* may have substantially similar or dissimilar orientations to each other in the three dimensional space without departing from the spirit and scope of the present invention. For example, the antenna component **502.1** through **502**.*m* antenna component **502.1** through **502**.*m* may be implemented on a first plane in the three dimensional space and the antenna impedance elements **802.1** through **802**.*m* may be implemented on a second plane in the three dimensional space such that the antenna impedance elements **802.1** through **802**.*m* may be oriented to be substantially parallel to their corresponding antenna component **502.1** through **502**.*m*.

The antenna element **800** may represent an inductor or coil of wire that is placed within the NFC device. The antenna element **800** may represent a printed circuit that is formed onto a printed circuit substrate. The antenna components **502.1** through **502**.*m* may be formed on a layer of the printed circuit substrate and the antenna impedance elements **802.1** through **802**.*m* may be also formed on the layer of the printed circuit substrate or other layers of the printed circuit without departing from the spirit and scope of the present invention. Alternatively, the antenna element **800** may be formed onto one or more semiconductor chips or dies using a semiconductor photolithographic process. The antenna components **502.1** through **502**.*m* may be formed on one or more semiconductor chips or dies and the antenna impedance elements **802.1** through **802**.*m* may be also formed on the one or more semiconductor chips or dies or other semiconductor chips or dies that are coupled to the one or more semiconductor chips or dies without departing from the spirit and scope of the present invention.

The operator may touch, directly with a finger or a hand or through other passive objects available to the operator such as a stylus, or be sufficiently proximate to, one or more of the antenna components **804.1** through **804**.*m* to operate and/or control the NFC device. For example, the operator may touch, or be sufficiently proximate to, one or more of the antenna components **502.1** through **502**.*m* and/or one or more of the antenna impedance elements **802.1** through **802**.*m*. The operator's touching of, or sufficient proximity to, causes a change in a characteristic impedance of the one or more of the antenna components **804.1** through **804**.*m*.

FIG. **8**B illustrates the second block diagram of the antenna element that is implemented as part of the antenna module according to a second exemplary embodiment of the invention. An antenna element **808** may generate a magnetic field to provide a transmitted information communication, such as the transmitted information communication **256** to provide an example. Other NFC capable devices may inductively couple a received communication signal, such as the received communication signal **258** to provide an example, onto the antenna element **808**. Additionally, an operator may operate and/or control a NFC device, such as the first NFC device **102**, the second NFC device **104**, and/or the NFC device **200** to provide some examples, by touching, or being sufficiently proximate to, the antenna element **808**. The antenna element **808** may represent an exemplary embodiment of the antenna module **206**. The antenna element **808** shares many substantially similar features as the antenna element **800**; therefore, only differences between the antenna element **800** and the antenna element **808** are to be discussed in further detail.

The antenna element **808** includes antenna components **810.1** through **810**.*m* that are configured and arranged in series with each other. Alternatively, each of the antenna components **810.1** through **810**.*m* may be configured and arranged to be parallel with each other. In another alternative, a first group of the antenna components **810.1** through **810**.*m* may be configured and arranged in series with each other and a second group of the antenna components **810.1** through **810**.*m* may be configured and arranged to be parallel with each other. Each of the antenna components **810.1** through **810**.*m* include a corresponding antenna component **502.1** through **502**.*m* that is directly coupled to a corresponding antenna impedance element **812.1** through **812**.*m*.

FIG. **9** illustrates a second configuration of the antenna element according to an exemplary embodiment of the inven-

tion. An operator may operate and/or control a NFC device, such as the first NFC device **102**, the second NFC device **104**, and/or the NFC device **200** to provide some examples, by touching, or being sufficiently proximate to, antenna components **902.1** through **902.4** of an antenna element **900**. The antenna element **900** may represent an exemplary embodiment of the antenna element **500**.

As shown in FIG. **9**, the antenna element **900** includes antenna components **902.1** through **902.4** configured and arranged in series with each other. However this example is not limiting, those skilled in the relevant art(s) will recognize that the antenna element **900** may include more or less antenna components without departing from the spirit and scope of the invention. The antenna component **902.1** is further coupled to a first connection **904.1** and the antenna component **902.4** is further coupled to a second connection **904.2**. The antenna components **902.1** through **902.4** may be characterized by a characteristic impedance from among characteristic impedances Z_1 through Z_4. Typically, the antenna components **902.1** through **902.4** may be characterized as being substantially symmetrical in configuration and arrangement from one another.

Each of antenna impedance elements **906.1** through **906.4** are either directly and/or indirectly coupled to a corresponding one of the antenna components **902.1** through **902.4**. Generally, the antenna impedance elements **906.1** through **906.4** are implemented using any regular and/or irregular geometric shape that is characterized by a corresponding characteristic impedance from among characteristic impedances ζ_1 through ζ_4. Typically, the characteristic impedances ζ_1 through ζ_4 are characterized as being a substantially different from one another such that the effective characteristic impedances of the antenna components **902.1** through **902.4** are substantially different. Typically, the antenna impedance elements **906.1** through **906.4** are configured to be normal to their corresponding antenna components **902.1** through **902.4** such that a performance of the antenna element **900** in sending and/or receiving information is negligibly affected by the antenna impedance elements **904.1** through **906.4**

A Second Exemplary NFC Device

FIG. **10** illustrates a block diagram of a second NFC device that is implemented as part of the NFC environment according to an exemplary embodiment of the invention. A NFC device **1000** is configured to operate in a target, or tag, mode of operation to respond to a request to exchange information, such as data and/or one or more commands to provide some examples, with another NFC capable device. An operator may operate and/or control the NFC device **1000** using a user interface and/or may touch, or be sufficiently proximate to, an antenna module of the NFC device **1000**. For example, the operator may provide information to the NFC device **1000** by touching, or being sufficiently proximate to, the antenna module. The NFC device **1000** includes the controller module **202**, the modulator module **204**, the antenna module **206**, the demodulator module **208**, the signal metric measurement module **210**, and a power harvesting module **1002**. The NFC device **1000** may represent an exemplary embodiment of the first NFC device **102** and/or the second NFC device **104**.

The NFC device **1000** shares many substantially similar features as the NFC device **200**; therefore, only differences between the NFC device **200** and the NFC device **1000** are to be discussed in further detail. The power harvesting module **1000** may harvest a power source from the received communication signal **258**. The power source may include sufficient power to adequately operate the controller module **202**, the modulator module **204**, the antenna module **206**, the demodulator module **208**, and/or the signal metric measurement module **210**.

A Third Exemplary NFC Device

FIG. **11** illustrates a block diagram of a third NFC device that is implemented as part of the NFC environment according to an exemplary embodiment of the invention. A NFC device **1110** is configured to operate in a communicator mode of operation to initiate an exchange of information, such as data and/or one or more commands to provide some examples, with other NFC capable devices and to respond to a request to exchange the information from other NFC capable devices. An operator may operate and/or control the NFC device **1110** using a user interface and/or may touch, or be sufficiently proximate to, an antenna module of the NFC device **1100**. For example, the operator may provide information to the NFC device **1100** by touching, or being sufficiently proximate to, the antenna module. The NFC device **1110** includes the controller module **202**, the modulator module **204**, the antenna module **206**, the demodulator module **208**, the signal metric measurement module **210**, and the power harvesting module **1002**. The NFC device **1100** may represent an exemplary embodiment of the first NFC device **102** and/or the second NFC device **104**.

The NFC device **1100** is configured to operate in a substantially similar manner as the NFC device **200** when operating in an initiator, or reader, mode of operation or in a substantially similar manner as the NFC device **1000** when operating in a target, or tag, mode of operation. The NFC device **1100** may be configured to operate in the reader mode of operation to initiate a communication with another NFC capable device. Alternatively, the NFC device **1100** may be configured to operate in the tag mode of operation to respond to a request from another NFC capable device to initiate communication.

Conclusion

It is to be appreciated that the Detailed Description section, and not the Abstract section, is intended to be used to interpret the claims. The Abstract section may set forth one or more, but not all exemplary embodiments, of the invention, and thus, are not intended to limit the invention and the appended claims in any way.

The invention has been described above with the aid of functional building blocks illustrating the implementation of specified functions and relationships thereof. The boundaries of these functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternate boundaries may be defined so long as the specified functions and relationships thereof are appropriately performed.

It will be apparent to those skilled in the relevant art(s) that various changes in form and detail can be made therein without departing from the spirit and scope of the invention. Thus the invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A communications device, comprising:

an antenna module, having a plurality of antenna components, configured to receive a communications signal, the plurality of antenna components comprising:

a plurality of geometric shapes coupled in series, each of the plurality of geometric shapes being characterized by a corresponding characteristic impedance from among a plurality of characteristic impedances, the

corresponding characteristic impedance being configured to change in response to an operator being sufficiently proximate to its corresponding geometric shape;

a signal metric measurement module, coupled to the antenna module, configured to determine a signal metric, the signal metric changing from a first metric value to a second metric value in response to the operator being sufficiently proximate to a geometric shape from among the plurality of geometric shapes; and

a controller module configured to:

determine a change between the first metric value and the second metric value, and

determine a location of the geometric shape that is sufficiently proximate to the operator based upon the change,

wherein the antenna module, the signal metric measurement module, and the controller module are further configured to control operation of the communications device in response to the communications device being configured to operate on power harvested from the communications signal.

2. The communications device of claim **1**, wherein a characteristic impedance, from among the plurality of characteristic impedances, corresponding to the geometric shape that is sufficiently proximate to the operator changes from a first impedance value to a second impedance value when the operator is sufficiently proximate to the geometric shape.

3. The communications device of claim **2**, wherein the change in the characteristic impedance causes the change between the first metric value and the second metric value.

4. The communications device of claim **1**, wherein the signal metric changes from the first metric value to the second metric value in response to the operator touching to the geometric shape.

5. A communications device, comprising:

an antenna module, having a plurality of antenna components, configured to receive a communications signal;

a signal metric measurement module, coupled to the antenna module, configured to determine a signal metric, the signal metric changing from a first metric value to a second metric value in response to an operator being sufficiently proximate to an antenna component from among the plurality of antenna components; and

a controller module configured to:

compare the signal metric to a previous signal metric to determine a change between the first metric value and the second metric value,

match the change between the first metric value and the second metric value with a signal metric change from among a plurality of signal metric changes, and

associate the signal metric change with the antenna component to determine a location of the antenna component that is sufficiently proximate to the operator,

wherein the antenna module, the signal metric measurement module, and the controller module are further configured to control operation of the communications device in response to the communications device being configured to operate on power harvested from the communications signal.

6. The communications device of claim **5**, wherein the controller module is further configured to associate the antenna component with information from among a plurality of information.

7. The communications device of claim **5**, wherein the previous signal metric comprises:

a predetermined signal metric that has been determined by the signal metric measurement module without the operator being sufficiently proximate to the antenna component.

8. The communications device of claim **1**, wherein the plurality of geometric shapes is configured and arranged to form at least one selected from a group consisting of:

a symmetrical antenna; and

an asymmetrical antenna.

9. The communications device of claim **1**, wherein the plurality of antenna components further comprises:

a plurality of antenna impedance elements, each of the plurality of antenna impedance elements being coupled to a corresponding geometric shape from among the plurality of geometric shapes.

10. A communications device, comprising:

an antenna module having a plurality of antenna components, the plurality of antenna components comprising:

a plurality of geometric shapes coupled in series, each of the plurality of geometric shapes being characterized by a corresponding characteristic impedance from among a plurality of characteristic impedances, the corresponding characteristic impedance being configured to change in response to an operator being sufficiently proximate to its corresponding geometric shape,

wherein the antenna module is configured to receive a communications signal from a magnetic field generated by a second communications device, a signal metric of the received communications signal changing from a first metric value to a second metric value in response to an operator being sufficiently proximate to a geometric shape from among the plurality of geometric shapes; and

a controller module configured to:

determine a change between the first metric value and the second metric value, and

determine a location of the geometric shape that is sufficiently proximate to the operator based upon the change,

wherein the antenna module and the controller module are further configured to control operation of the communications device in response to the communications device being configured to operate on power harvested from the received communications signal.

11. The communications device of claim **10**, wherein a characteristic impedance, from among the plurality of characteristic impedances, corresponding to the geometric shape that is sufficiently proximate to the operator changes from a first impedance value to a second impedance value when the operator is sufficiently proximate to the geometric shape.

12. The communications device of claim **11**, wherein the change in the characteristic impedance causes the change between the first metric value and the second metric value.

13. The communications device of claim **10**, wherein the signal metric changes from the first metric value to the second metric value in response to the operator touching to the geometric shape.

14. A communications device, comprising:

an antenna module, having a plurality of antenna components, configured to receive a communications signal from a magnetic field generated by a second communications device, wherein a signal metric of the received communications signal changes from a first metric value to a second metric value in response to an operator being sufficiently proximate to an antenna component from among the plurality of antenna components; and

a controller module configured to:

compare the signal metric to a previous signal metric to determine a change between the first metric value and the second metric value,

match the change between the first metric value and the second metric value with a signal metric change from among a plurality of signal metric changes, and

associate the signal metric change with the antenna component to determine a location of the antenna component that is sufficiently proximate to the operator,

wherein the antenna module and the controller module are further configured to control operation of the communications device in response to the communications device being configured to operate on power harvested from the received communications signal.

15. The communications device of claim **14**, wherein the controller module is further configured to associate the antenna component with information from among a plurality of information.

16. The communications device of claim **14**, wherein the previous signal metric comprises:

a predetermined signal metric that has been determined without the operator being sufficiently proximate to the antenna component.

17. The communications device of claim **10**, wherein the plurality of geometric shapes is configured and arranged to form at least one selected from a group consisting of:

a symmetrical antenna; and

an asymmetrical antenna.

18. The communications device of claim **10**, wherein the plurality of antenna components further comprises:

a plurality of antenna impedance elements, each of the plurality of antenna impedance elements being coupled to a corresponding geometric shape from among the plurality of geometric shapes.

19. The communications device of claim **1**, wherein the communications device is configured to operate in a tag mode of operation.

20. The communications device of claim **10**, wherein the communications device is configured to operate in a tag mode of operation.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,105,965 B2
APPLICATION NO. : 13/157572
DATED : August 11, 2015
INVENTOR(S) : Cox et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title Page, Item (74), please replace "Sterne, Kessler, Goldstein & Forr, P.L.L.C." with --Sterne, Kessler, Goldstein & Fox, P.L.L.C.--.

Signed and Sealed this
Fifteenth Day of March, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office